

# DEMOGRAFX

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Federal Communications Commission  
Washington DC

**DOCKET FILE COPY ORIGINAL**


Dear Commission,

DemoGraFX has enclosed a single copy of the three CD ROM's which are included as part of our comments. This one copy is being sent in the submission to the Honorable Chairman Reed Hundt.

If further copies are required for analysis and evaluation, or if there are any problems reading these submitted CD-ROM's, please don't hesitate to contact us at our address on the letterhead above.

We hope that the commission investigates the issues raised in our comments.

Sincerely,



Gary Demos, President/CEO



Allan Peach, Vice President, Technology Projects

DemoGraFX

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Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, D.C. 20554

In the Matter of )

Advanced Television Systems and Their )  
Impact Upon the Existing Television )  
Broadcast Service )

MM Docket No. 87-268

To: The Commission

COMMENTS OF DEMOGRAFX

DemoGraFX<sup>1</sup>, a California Small Business Corporation, hereby comments on the Fifth Further Notice of Proposed Rule Making (the "Notice") in the above-captioned proceeding.

Please also see comments filed before the commission by DemoGraFX, on 13 December 1991 in response to a previous notice in the above-captioned proceeding. Issues were raised in these previous comments, most of which remain problematic within the current Advisory Committee on Advanced Television Service (ACATS) proposal that is the subject of this present Notice.

1. Introduction, and Summary of These Comments

According to the Notice, the commission is considering adopting the ACATS proposal, without modification, as submitted. Further, the commission is apparently favoring the notion of exclusively allowing the ACATS proposed formats.

DemoGraFX feels that if the commission proceeds along these lines, that the new ATV system that the commission would be putting into place for our nation would result in complete incompatibility with computers, and would thereby almost certainly prevent ATV from fulfilling its potential as a key enabler for a National Information Infrastructure (N.I.I.). The commission would also thereby miss a crucial chance for our Nation to abandon the obsolete system parameters of interlace and 60 Hz.

DemoGraFX recognizes that many people spent a great deal of effort on the work of ACATS. However, in our fast-changing digital world, the scope of such an effort must adjust to meet the inherent challenges. The ACATS work spanned a duration where many generations of digital computer advancement have taken place. Unfortunately, the work of ACATS did not keep pace

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<sup>1</sup> These comments have been prepared by Gary Demos, President/CEO of DemoGraFX, with further input from Allan Peach, Vice President of Technology Projects. DemoGraFX is a developer of new technologies in the areas of image processing, computer graphics, and high performance I/O. DemoGraFX is also an active consultant since 1992 to Apple Computer on Digital Advanced Television. DemoGraFX has also been a consultant and technology developer for numerous other computer and film companies, including Universal Studios, Pacific Title Digital, Microsoft, Sun Microsystems, NCR, Hewlett Packard, IBM, and Digital Equipment Corporation. These comments are the comments solely of DemoGraFX, and do not represent any other company.

with the world around it, and therefore has yielded a result containing television-like formats, without recognizing the lessons learned in information display by the computer industry. A digital revolution has also swept the motion picture industry. These lessons, too, did not find their way into the work of ACATS.

DemoGraFX has sought diligently over the last six years to make the ACATS committee aware of their changing environment, and to help redirect the work so that the result would be both relevant and advantageous to our Nation. However, as will be documented in great detail in these comments, ACATS remained insular to this input. ACATS therefore did not adjust itself to make the effort expended yield the needed result.

DemoGraFX recommends that the commission not adopt the Advisory Committee on Advanced Television Service (ACATS) recommendation for a digital television standard.

DemoGraFX recommends that the commission forbid introduction of interlaced formats into U.S. digital television systems within its jurisdiction. If the commission does not so forbid, the result is likely to be that the Japanese interlaced standard would become the dominant U.S. standard for High Definition Television (HDTV)<sup>2</sup>, and the existing interlaced NTSC standard would become the dominant national standard for digital Standard Definition Television (SDTV). The nation will thereby be precluded from the benefits that Advanced Television systems might afford to the creation of a National Information Infrastructure (NII), which requires the prevention of interlace.

DemoGraFX also recommends that the commission require that all non-interlaced formats retain full vertical resolution. This would ensure that non-interlaced displays are not disadvantaged by filtering prior to transmission to reduce vertical resolution for interlaced display of non-interlaced formats.

DemoGraFX recommends that the commission forbid the used of interlaced display in all new digital television receivers. In this way, all new digital shows and interactive programs such as education and web browsing would be confident that the entire new digital receiver population will be able to view legible text if such programs are composed with full vertical resolution. This recommendation would be equivalent to requiring computer-compatible, and therefore N.I.I.-compatible, displays for new digital television receivers.

DemoGraFX recommends that the commission reject the formats based upon 60 Hz. The ACATS proposal is clearly biased toward display of all formats on 60 Hz interlaced displays. For non-interlaced displays, and for computer-compatible displays, which must exceed 70 Hz<sup>3</sup> in their display rate, extra cost is added to every receiver. Further, quality is lost, in spite of this extra cost burden. Thus, the ACATS proposed rates of 29.97, 30, 59.94, and 60 Hz should be rejected. DemoGraFX recommends consideration of 72 Hz as a more natural display rate for advanced television.

DemoGraFX recommends that the commission also forbid the practice of sending film using 3-2 pulldown. Although the ACATS proposal before the commission includes a 24 frame-per-second mode for film, there is no requirement that film shown via digital ATV will be sent in this mode.

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<sup>2</sup> The 1920 x 1080 format at 60 Hz and 59.94 Hz interlace that is being proposed by ACATS to the commission, as shown in this Notice, is essentially equivalent to the Japanese Analog HDTV standard.

<sup>3</sup> R. A. Pearson, "Predicting Video Display Terminal (VDT) Flicker". *Information Display* volume 7, no 7, pp 28, July-August, 1991.

The ACATS proposal allows film to be sent at 59.94 or 60 Hz via the 3-2 pulldown technique. This technique is costly to undo at each receiver, if a receiver wishes to display the film at 72 Hz, which is a computer-compatible display rate. If any portion of the material broadcast using the ACATS proposed system uses the 3-2 technique, then either the display will need to go blank, or else the receiver must be burdened by complex 3-2 pulldown detection and inversion equipment. By allowing 3-2 pulldown when sending film, a significant bias would be established against interoperability with computer displays, which must operate at rates exceeding 70 Hz. This bias would be in addition to the bias within the 60 Hz and 59.94 Hz formats being proposed by ACATS.

DemoGraFX recommends that the commission disallow non-square-pixel spacing in digital ATV formats. Those formats within the ACATS proposal based upon a horizontal resolution of 704, which thereby have non-square pixel spacing, should be prohibited. Only formats having square pixel spacing should be allowed. This is especially needed to help enable low-cost software-only decoders, which will be available in the near future on personal computers and set-top-box decoders. Allowing non-square-pixel spacings in formats will disadvantage such decoders, which are anticipated to be a major trend in highly cost-effective ATV receivers. All computer-compatible displays use square pixel spacing, so non-squarely spaced formats must be converted, burdening every such device with conversion circuits, or extra software decoding steps, if any such non-squarely spaced formats are allowed.

DemoGraFX recommends that the commission not let the market decide, because that will have the same near-term result as accepting ACATS. Letting the market decide would most likely yield only interlaced standards for the United States in the near term, and would thereby deny our nation of the potential of ATV becoming a key enabler for the N.I.I. Once such interlaced formats are deployed, it will be nearly impossible to recall them. The commission must therefore intervene with market forces within its jurisdiction, to "level the playing field" so that non-interlaced formats can become the new digital standard for our nation. The ACATS proposal, which allows that there be the "option for interlace" in Advanced Television, is the very foot in the door for interlaced equipment that will result in mostly interlaced formats being deployed in our nation. Further, once new digital interlaced broadcast facilities and new receivers enter the market, especially those in the Japanese HDTV format, there will be no way to migrate away from interlace. It will become permanent for many decades, once deployed. Even if non-interlaced equipment followed the initial deployment of interlaced equipment, the support of the interlaced equipment would force many degradations to the non-interlaced systems. These degradations include poorer vertical resolution in shows, so that they can be transmitted and/or displayed using interlaced equipment and/or receivers.

The degradations include the costly requirement that non-interlaced receivers have "de-interlacers" when receiving shows coming from interlaced broadcasters. For example, all computer-compatible, and N.I.I.-compatible displays would be burdened with not only de-interlacers, but also frame rate conversion. The combination of rate conversion and de-interlacing is both costly and artifact-prone. As a point of reference, devices which convert European PAL television to United States NTSC television, perform similar processing to that needed by computer-compatible and N.I.I.-compatible displays. Such PAL to NTSC converters cost \$50,000 at present for medium quality conversion, and \$250,000 for high quality conversion. These devices only operate at the low resolution of existing NTSC. Higher cost devices would be needed for HDTV formats. It is clear by these costs that the barriers placed against computer interoperability by the ACATS proposal are so great as to be practically insurmountable. Claims in the notice that the ACATS proposal is interoperable with computers would only be true if the interlaced formats were to be removed, and if the frame rates were to be adjusted from 30 and 60 Hz to formats exceeding 70 Hz.

Contrary to representations within the Notice, the ACATS proposed ATV system is highly incompatible with computers. As proposed, the ACATS ATV system would achieve interoperability with computers only at very great expense, and with significant quality loss. It is therefore highly likely that if the commission adopts ACATS' proposal, that two mutually-incompatible standards will result. One or more ATV systems which are computer compatible will be created, and there would be the ACATS standard, which is not compatible with computers. Wherever there is a closed system that is not within the jurisdiction of the commission, computer-compatible ATV systems will be utilized. Such systems are fundamentally incompatible with the ACATS proposal, much as PAL and NTSC are highly incompatible. Thus, the commission's proposed acceptance of the ACATS proposal would result in the creation of at least two incompatible television standards in the United States, as if PAL and NTSC were both adopted at the same time within our country. The situation also bears resemblance to the VHS and Beta video tape incompatibility, and the resultant waste of many consumers' money. If no standard is set, then the situation that resulted from AM Stereo might again be the result. Thus, the commission is considering adopting a computer-incompatible standard, which would almost surely result in one or more other standards which are computer-compatible, but incompatible with ACATS. The commission may also be considering not setting a detailed standard, but rather "allowing" the ACATS proposed formats. This would then also allow computer-compatible formats in addition to the ACATS proposal, but such formats are mutually exclusive with ACATS, creating even greater problems.

In addition to these serious issues with the interlaced formats being proposed by ACATS, many other aspects of the ACATS proposed system are far from optimal. The ACATS proposal represents technology which will perform substantially less efficiently than other competing technologies for Advanced Television (ATV).

DemoGraFX therefore recommends that the commission neither adopt ACATS' recommendation, nor allow it. It is DemoGraFX recommendation that the commission discard the work of ACATS on video, and establish some mechanism by which a computer-compatible ATV system would result. Only in this way can our nation have the benefits associated with a single national standard, therefore saving consumers Billions of Dollars, while enabling a National Information Infrastructure (NII) through a national ATV system.

It is not our intention to promote our own technology using these comments. It is our primary consideration that the flaws in ACATS be rectified. However, DemoGraFX has developed such a system which is substantially more efficient than that being proposed by ACATS, and we invite the commission to review this system and see it demonstrated prior to further consideration toward adopting the recommendations of ACATS. We approached the technical parameters of compression utilizing exhaustive methodical research to understand the fundamental underlying issues. During the course of this research, DemoGraFX discovered that the fundamental principles upon which the ACATS system is based were false. Having discovered this, DemoGraFX used these findings to assemble a system based upon the true underlying issues in compression technology. These discoveries are not mere assertions, but are demonstrable engineering facts, which can be independently duplicated by any sufficiently equipped digital television lab. For this reason, DemoGraFX seeks to ensure that the commission is aware of our results, and of the fundamental principles upon which these results are based. DemoGraFX feels that our results should be sufficient reason to halt any consideration of adopting the ACATS proposal. The benefits of our discovery drastically affect both the compression (and spectrum) efficiency, the delivered quality, and also the ability to enable true convergence for computing, consumer electronics, and telecommunications. The DemoGraFX system substantially reduces the cost of digital television receivers through the use of a "base layer" approach to provide improved digital television, and an "enhancement layer" approach to achieve high definition television.

It has long been asserted by members of the Grand Alliance, and by members of ACATS, that layered compression within the 6MHz channel at full 1000 lines resolution, without interlace, and having a high frame rate, would not be possible until sometime far in the future. These assertions have been fundamental to the ACATS proposed formats, which are the subject of this notice. It is highly unlikely that ACATS would be proposing their 18 disparate formats had the ACATS participants discovered a way to build an efficient layered compression system. However, DemoGraFX has discovered simple modifications to the MPEG-2 technology used by the ACATS proposal, which yield these very results.

The DemoGraFX system also seeks to enable the convergence of Advanced Digital Television, Computing, and the Movie Industry. The ACATS proposal creates artificial barriers to this convergence through the use of interlaced formats, a 60 Hz television-like frame rate (incompatible with computer displays), an aspect ratio which is not optimal (16:9), limited colorimetry, lack of appropriate data transport, formats with non-square pixel spacing, and other problems. The ACATS proposal further specifies not one digital television standard, but rather 18 different standards.

By contrast, the DemoGraFX system eliminates all of these barriers through the elimination of interlace, the use of 72, 36, and 24 Hz frame rates, a more cinematic screen aspect ratio (2:1), broader "film-like" colorimetry, and square pixel spacing. By utilizing a single standard which is layered, we are able to replace the 18 different ACATS formats, while providing superior quality over each and every ACATS proposed format. Further, the DemoGraFX system does this at a much lower cost for the typical digital advanced television receiver through the use of a cheaply-decodeable base layer. For the high definition enhancement layer, the cost of the DemoGraFX system is approximately equivalent to the ACATS proposal at High Definition Television (HDTV) resolutions, while providing higher quality with no visible artifacts (unlike the ACATS interlaced formats, which have highly visible and objectionable artifacts). DemoGraFX has also developed guidelines which can be utilized to amend the data transport system being proposed by ACATS such that it would then be suitable for carrying a wide variety of data.

The main reason that DemoGraFX has worked so diligently on searching for an appropriate ATV system architecture, is that we have had a keen awareness for many years that the ACATS process was unlikely to develop a system which would be appropriate for the United States. As will be thoroughly documented in these comments, DemoGraFX has consistently sought for the last six years to point out the serious flaws within the formats under consideration by ACATS, in the hope that ACATS would attend to these issues raised. However, it has been apparent in the recent two years that the work of ACATS no longer intended to address these issues. Therefore, DemoGraFX has sought to find technical solutions on our own.

These comments seek to summarize the serious and persistent problems with the proposal that ACATS has now put before the commission, which is the subject of the Notice. DemoGraFX also suggests our proposed system as a complete alternative, involving only simple modifications to the ACATS coding (MPEG-2) and transmission technology, yet yielding a profound improvement in computer interoperability, reduced receiver cost, spectrum efficiency, and improved presentation performance. DemoGraFX' system outperforms the ACATS proposal by a substantial margin in every video format, while providing all of the video formats in a single layered system.

DemoGraFX recognizes that these claims are bold, in light of the many man-years of effort and funding expended by Grand Alliance members and others on developing the proposal by ACATS. However, DemoGraFX built its system upon the same foundation upon which the ACATS proposal is based, the MPEG-2 compression system, which is now internationally standardized. The MPEG-2 standardization efforts, therefore, form a common technical basis for the DemoGraFX proposal, as well as for the ACATS proposal currently before the commission.

DemoGraFX also recognizes that the commission may not accept these assertions, even upon seeing demonstrations and upon hearing the testimony of witnesses who have seen and verified the DemoGraFX system. DemoGraFX is therefore taking the unusual step of submitting our attached technical paper<sup>4</sup>, which describes the DemoGraFX layered MPEG-2 technique, together with three CD-ROM's, which contain data. These CD-ROMs, together with this paper, can be used to independently verify that the DemoGraFX system indeed operates as described. These CD-ROMs<sup>5</sup> contain data which proves that layered compression at 1000 lines and high frame rates can be achieved without interlace within the 6MHz television channel. DemoGraFX thus asks the commission to submit these materials to an independent and unbiased outside group for an evaluation. It is hoped that this evaluation could be completed in a few weeks by an expert independent group<sup>6</sup>. Such an independent evaluation could then be used by the commission as expert testimony concerning the DemoGraFX system as an alternative to the ACATS proposal. DemoGraFX sincerely hopes that the commission will take appropriate steps to obtain such independent verification prior to making any decisions toward accepting the ACATS proposal, as is suggested in the Notice. The widely admitted flaws of ACATS, which appear to become permanent once deployed, can all be entirely avoided within the structure of our alternative system.

In the separate statement of the Honorable Commissioner Susan Ness, she says:

"Given the openness of the process and years of consideration, including previous Commission decisions, I believe that the burden of showing why we should not adopt the standard or why the standard has significant flaws lies with the proponents of that view"

and goes on to say, at the end of her statement:

"Although I remain open to arguments that it has major flaws, advocates of other systems have a high burden to show that their standards are not theoretical but have passed the same rigorous testing as the ATSC standard."

In the separate statement of the Honorable Chairman Reed Hundt, he states:

"To be sure, while we have broad industry consensus we do not have unanimity. Concerns have been raised about specific elements of the ATSC Standard. Segments of the computer industry, including Microsoft Corporation and Apple Computer, object to the presence of interlaced scanning formats in the proposed standard. And many moviemakers and other artists, including

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<sup>4</sup> Attached as Appendix I.

<sup>5</sup> The CD-ROM's attached to this submission are provided to the commission with a limited-use non-exclusive license. This license is for the purpose of evaluation of the DemoGraFX system. The CD-ROM data may not be sub-licensed by the government. The CD-ROM may not be utilized for any commercial purpose under this license, and is not being placed in the public domain. The commission may provide this CD-ROM data to any appropriate government or private agency for the sole purpose of evaluating the DemoGraFX layered compression technology.

<sup>6</sup> DemoGraFX recommends that the commission consider the independent laboratory of Dr. Charles P. Fenimore, National Institute of Standards and Technology (NIST), Route 270 Quince Orchard Rd, Bldg 220, Rm B-343, Gaithersburg, MD 20899. Phone: 301 975 2428.

the members of the American Society of Cinematographers, object to the inclusion of a 16:9 aspect ratio.

Each of these groups raises concerns that cannot be dismissed out of hand. We ought to have a standard that guarantees interoperability between TVs and computers. And we ought to have a standard that promotes artistic creativity. Proponents of the ATSC Standard maintain that it accommodates the concerns of the computer and entertainment industries, and I know personally that the Advisory Committee worked diligently to try to do so. We need thorough comments and full participation on these important issues."

Section VIII of the Notice, the Conclusion, states as follows:

"We ask commenters to provide us their detailed and well-supported comments upon our proposal, as well as the other issues raised in this Notice, so that we may have a complete and current record upon which to base our final conclusions and bring the benefits of digital broadcast technology to the American people."

These words clearly indicate that a brief response to the Notice would not be appropriate for the DemoGraFX message to the commission. Our comments seek to show that the ACATS system is substantially flawed, and that it is significantly inferior technically to the DemoGraFX proposal.

For these reasons, DemoGraFX begs the indulgence of the commission for this long and detailed response. DemoGraFX feels that our comments must be detailed and complete, and must be supported with technical documents and data (via CD-ROM) as well as complete records of procedural issues relating to the ACATS process which have lead to the fundamental technical flaws within ACATS.

To summarize, DemoGraFX seeks to prove to the commission that the ACATS proposal is flawed in fundamental and serious ways. The ACATS proposal is based upon fundamentally false or obsolete premises concerning interlace and image coding efficiency. DemoGraFX is herein providing proof that these fundamental premises are false by providing data which demonstrates that non-interlaced layered HDTV coding at high frame rates is fully available to the nation and to the commission. The DemoGraFX system works, and it is demonstrable. Its very existence totally invalidates the ACATS proposal.

### **1.1 Specific Recommendation Summary**

DemoGraFX makes the following recommendations to the commission:

- The commission may accept the 8/16 VSB modulation system proposed by ACATS<sup>7</sup>.
- The commission may accept the audio work, selecting Dolby AC-3, as proposed by ACATS<sup>8</sup>. Some are claiming that there are better audio technologies than AC-3, with potentially better

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<sup>7</sup> DemoGraFX does not have expertise in modulation systems, so we defer to the commission concerning whether this modulation is appropriate. DemoGraFX believes that the ACATS work on modulation testing was correctly conducted, although we do not know if this system is optimal. DemoGraFX is concerned about the intended use of QAM in some cable systems, and would hope that the commission could find a way to avoid the requirement that receivers have both QAM and VSB demodulators in favor of a single demodulator (either QAM or VSB).

<sup>8</sup> DemoGraFX does not have expertise in audio coding algorithms, so we defer to the commission concerning whether this audio coding is appropriate. DemoGraFX believes that the ACATS work

quality. We believe that the commission should investigate this, but DemoGraFX has no opinion or experience concerning this issue, and we do not object to Dolby AC-3. Some of these objections may be addressed by allocating more than the 384kbits/second for audio which is being proposed by ACATS as nominal, and by raising the maximum bit rate ceiling for audio.

- DemoGraFX recommends that the commission reject all other aspects of the ACATS recommendations.
- DemoGraFX recommends that the commission send the transport system to a competent committee for additional work, to provide error-free data delivery to the primary coverage area<sup>9</sup>.
- DemoGraFX recommends that the commission not specify 18 formats, but rather that the commission standardize a "base layer" ATV system. We recommend that the commission send the work of defining this base layer to a competent committee, with the guideline that the base layer be defined by a reference decoder. If the commission does not wish the delay of a committee, the commission may also consider the base layer specified here<sup>10</sup>.
- DemoGraFX recommends that the enhancement layer technique proposed by DemoGraFX be standardized as being optionally allowed to provide both resolution and frame-rate (temporal) enhancement<sup>11</sup>.
- DemoGraFX recommends that the commission forbid the use of interlace in the base layer or any enhanced layer of the ATV system. As the commission is aware, interlace forms an absolute barrier to the convergence of computing and television. By allowing any interlaced formats, the commission would be enshrining into law the prevention of the development of an ATV system which could enable a National Information Infrastructure. Interlace is also very problematic in the production of shows, and is widely opposed in the movie production community. The commission should consider its unique chance to seize this opportunity to abandon the obsolete<sup>12</sup> practice of interlace.

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on audio coding was correctly conducted, although we don't know if this system is optimal. DemoGraFX is concerned about the intended use of Musicam audio in some cable and satellite systems, and would hope that the commission could find a way to avoid the requirement that receivers have both Musicam and Dolby AC-3 audio decoders in favor of a single decoder (either Musicam or Dolby AC-3).

<sup>9</sup> The proposed ACATS data transport system has an error rate sufficient for audio and video, using error masking techniques. However, the error rate is not sufficient for data and code uses, thus precluding many highly valuable applications of the broadcast spectrum. Both the packet system, using MPEG-2 systems transport packets, and the error-correction system, using trellis and Reed-Solomon coding will require re-design in order to support data and code applications. A revised packet structure will be needed, together with an additional layer of Reed-Solomon code and a corresponding error interleave.

<sup>10</sup> A base layer definition, as recommended by DemoGraFX is specified in *Appendix J*.

<sup>11</sup> An enhancement layer specification, as recommended by DemoGraFX, is included in *Appendix K*.

<sup>12</sup> Interlace was invented as a way to trick the eye into preceiving an acceptable picture with reduced analog transmission bandwidth. It was developed in the 1920's and 1930's, and was included in NTSC in 1940. Unfortunately, interlace permanently damages an image signal in irreparable ways. In digital systems, much better methods of bandwidth compression are

- DemoGraFX recommends that the commission forbid the use of 29.97, 30, 59.94, and 60 Hz, and that the commission allow only the use of 24, 36, and 72 Hz image update rates in the base layer and any enhanced layer of the ATV system. The commission should consider its unique chance to take advantage of this opportunity to abandon the obsolete television rates based upon 60 Hz and 59.94 Hz.
- DemoGraFX recommends that the commission also forbid the use of 3-2 pulldown by prohibiting the transmission of 59.94 and 60 image update rates.
- DemoGraFX recommends that the commission forbid the use of "B" frames in the reference decoder, but permit their use as temporal enhancement in any enhancement layer<sup>13</sup>.
- DemoGraFX recommends that the commission require overlay planes in the reference decoder. Reference planes persist (unlike MPEG-2 images), and would be created from data received by the reference decoder.
- DemoGraFX recommends that the commission require the reference decoder to be able to process one or more standard text and graphics formats for interpreting information for the overlay planes.
- DemoGraFX recommends that the commission forbid the use of overscan in new digital ATV receivers.
- DemoGraFX recommends that the commission forbid the cropping (for "pan-and-scan") of widescreen movies in transmission. DemoGraFX recommends that the commission allow cropping only as an option in the receiver, while requiring a corresponding "letterbox" option to display the image without cropping.
- DemoGraFX recommends that the commission use only 2.0 : 1 aspect ratio template for image coding for mastering and transmission of ATV.
- DemoGraFX feels that the 2.0 : 1 and 2.4 : 1 aspect ratios should not be disadvantaged as ATV displays, in spite of apparent plans for some companies to sell 16 : 9 aspect ratio displays. DemoGraFX recommends that the commission ensure that all biases in ATV formats favoring 16 : 9 aspect ratios for transmission and/or display be removed from the ATV specification.
- DemoGraFX recommends that the commission gives the task of defining an appropriate colorimetry to a qualified committee, with the instructions that film colorimetry must be able to be preserved through the ATV system. DemoGraFX recommends that the work of ACATS be

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available. In modern cameras, which are based upon CCD's, interlace is being synthesized from pairs of lines having a non-interlaced (progressive-scan) signal. On displays, the use of interlace generates unacceptable flicker on small items such as text and graphics, making it unuseable for such images. At no point in the television system is interlace beneficial. DemoGraFX feels that those who support the inclusion of interlace in ATV are doing so only for historical reasons involving existing available equipment, and not for any sound technical reasons.

<sup>13</sup> "B" frames form a natural temporal layering technique for temporal enhancement. However motion blur requirements constrain temporal layering to single "B" frames between "P" or "I" frames to temporally enhance from 36 to 72 Hz. Unfortunately, perceptual motion blur requirements do not allow either 24 or 30 Hz to form a temporal base layer.

rejected, since it only provides for preservation of video colorimetry, and not film colorimetry, and that a better colorimetry be developed<sup>14</sup>. Guidelines to this development should aim to achieve support for widening gamut and increasing dynamic range in new display technologies. DemoGraFX recommends that the commission take this opportunity to provide the highest quality color transmission, processing, and reproduction possible. DemoGraFX recommends that the commission not mandate into law the flawed and limited colorimetry being proposed by ACATS.

## **2. Detailed Comments, Background (Section II of the Notice)**

DemoGraFX will describe the detailed background of ACATS, and our attempt to raise these and other issues over the past six years. DemoGraFX will show that the ACATS process, and those who oversaw its operation, have long remained insular to comments suggesting that these problematic issues be examined and solved. From our perspective, the work of ACATS has not been an open process, but has behaved as if it were attempting to serve only a limited number of special interests. Apparently, these special interests have not wished to seriously pursue the convergence of computing, entertainment, and telecommunications, but have rather wished to keep entertainment as an island without useful interoperability, scalability, or extensibility. Further, the entertainment system being specified is only compatible with existing television entertainment, and is not inclusive of the needs of the broader motion picture community. Thus, the ACATS proposal which is the subject of this Notice is representative of only a small community of special interest, and does not represent an appropriate system for our nation as a whole. An appropriate system would enable the fullest potential for Advanced Television to be the key point of convergence between all forms of entertainment, computing, telecommunications, and the centerpiece of a National Information Infrastructure. We shall describe and document this perspective in substantial detail in this section of our comments.

In paragraphs 2 and 3 of the Notice, the formation and workings of the Advisory Committee on Advanced Television Service (ACATS) are described. ACATS was chartered over 8 years ago, in 1987. In 1988, ACATS initially planned to propose that the commission adopt the analog Japanese television HDTV standard as the United States standard. Fortunately, some U.S. industries and some broadcasters complained about this proposal, and the process was opened up to competition. However, the openings for entrants to this competition were only available until around 1989, when the competition was closed to new entrants. The significance of this can best be realized in the context of the digital technology as applied to video in 1989. At that time, digital video production equipment was in its first few years of introduction into production and post-production facilities, and was only beginning to achieve acceptance<sup>15</sup>. The MPEG committee

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<sup>14</sup> The "primary colors" which are specified in the ACATS proposal will not correctly reproduce the vivid colors of motion picture film. The ACATS proposed color primaries are based upon obsolete technical ingredients such as limited television phosphor colors, erroneous and irreversible linear matrix and filter processing of non-linear signals, among other limitations. The ACATS proposed system for colorimetry prevents accurate color transmission, processing, and reproduction. The dynamic range, while sufficient at present, is aimed at the short term. These limitations are not based upon technical or cost barriers, but are solely based upon historical incorrect color processing practices, and on the use of existing available equipment which embody these incorrect practices. These flaws can be corrected easily by allowing the specification of colorimetry primaries and dynamic representation in the ATV signal, and by mandating that linear signals be used with linear operators such as filters and matrices.

<sup>15</sup> With the exception of the work of people who are now within DemoGraFX, who were then in their former companies, very little digital video had been directly broadcast by this time.

was just beginning its technical work. Of most significance, however, was that digital video technology had not yet begun to be widely available on personal computers. CD-ROM's were about to be introduced, and "multi-media" computers did not yet exist as a consumer item. Thus, the direct consequence of closing the ACATS advanced television process to new entrants around 1989 was to preclude the entire multimedia computing industry from participation. In 1989, all of the proposals were analog HDTV systems. Most computer companies viewed such analog television systems as irrelevant to their future.

In 1990 a key new industry coalition, the Committee on Open High Resolution Systems (COHRS), which included DemoGraFX, and which included computer companies, began to recommend that HDTV be digital, and that the parameters associated with analog television, such as interlace and non-square-pixel-spacing be abandoned. Further, COHRS recommended that a high priority be placed upon the concepts of "Scalability", "Interoperability", and "Extensibility". These notions form core concepts that represented a course correction for ACATS and the ATSC. Unfortunately, however, ACATS and the ATSC have given only lip service to these concepts, and have failed completely to embody them seriously in their work. The ACATS proposal, which is the subject of this Notice, does not offer scalability, interoperability, or extensibility. ACATS and ATSC therefore failed to make the course correction recommended by COHRS, and continued in their former direction without addressing these needs.

In February of 1990, DemoGraFX sent a letter to the Advanced Television Systems Committee (ATSC) expressing concern over the direction of their work. This letter is included as *Appendix A* of these comments. At the time, the ATSC was debating between 2048 x 1152 vs 1920 x 1080<sup>16</sup>. This letter by DemoGraFX to the ATSC raises many of the more serious issues that still remain unresolved concerning 60 Hz, 59.94 Hz, and interlace. Although 24 Hz formats are now being proposed, neither the ATSC nor ACATS has responded in the intervening six years to the issues raised in this and subsequent letters concerning problems with 60 Hz, 59.94 Hz and interlace. The ACATS proposal before the commission has not proposed a solution to these issues raised, nor has any serious attempt been made during the intervening years, neither within ACATS nor within the ATSC, to address these issues concerning 60 Hz, 59.94 Hz, and interlace. DemoGraFX also recommended that the analog nature of the proposals being discussed be abandoned in favor of digital approaches.

To quote from this letter from DemoGraFX to the ATSC:

*"The computer industry would stand to benefit from a synergy between computer display requirements and emerging HDTV standards. Such a synergy is all but precluded by a 30/60 (29.97/59.94) Hz interlaced scanning recommendation.*

*The 1920 x 1080 30/60 (29.97/59.94) Hz interlaced recommendation favors analog implementations of HDTV. It is clearly in the best interests of the U.S. computer and semiconductor industries if HDTV standards are conceived as digital standards."*

To summarize the issues raised in this DemoGraFX letter of February 1990, which still remain problematic in the ACATS and ATSC proposal that is the subject of the Notice:

1. The computer industry is under-represented at the ATSC

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<sup>16</sup> At the time, only 16:9 aspect ratio formats were being discussed in the ATSC T4/S1 group. DemoGraFX favored 2048 x 1152 at that time, in the context of 16:9, but recommended that 2048 x 1024 be considered. DemoGraFX now favors 2048 x 1024, having a 2:1 aspect ratio, based upon key input in 1993 from the American Society of Cinematographers (ASC).

2. The film production industry is under-represented at the ATSC.
3. There are problems with the colorimetry being proposed by the ATSC.
4. 1920 horizontal is problematic. 2048 would be much more desirable.
5. Interlaced scanning at 60 or 59.94 Hz using the 1920 x 1080 format is extremely problematic for the film-production community and for the computer industry.
6. Problems with computer display compatibility at 59.94 or 60 Hz.
7. Problems with computer display compatibility due to interlace.
8. Problems with 24fps film display using 59.94 or 60 Hz (3-2 pulldown)
9. Provisions for efficient international format conversions are needed

Note that these issues have remained problematic and unaddressed by the ATSC and ACATS now for more than half a decade.

In May of 1991, DemoGraFX testified before the Committee on Science, Space, and Technology, Subcommittee on Technology and Competitiveness. This testimony is included in *Appendix B*. In that testimony, DemoGraFX attempted to focus the Advanced Television work going on at the FCC onto a National Information Infrastructure (N.I.I., although this term had not yet been coined). DemoGraFX raised numerous objections, most of which have remained unaddressed in the intervening five years. In particular, DemoGraFX described the problems regarding interlace, the 60 and 59.94 Hz frame rate, and the lack of scalable layering in the ACATS proposals. DemoGraFX also recommended that the focus of the ACATS work be shifted away from terrestrial broadcasting, toward a broader array of more likely delivery media. Further, DemoGraFX pointed out the lack of consideration in the ACATS process for the needs of the Hollywood film production community.

When reading this testimony, one can see that the problems outlined in detail in May of 1991 nearly all remain. The issues raised in this testimony are still present in the ACATS proposal that is being recommended for adoption by the current Notice. The fact that these issues were raised very visibly before congress and the FCC half a decade ago, and yet have not been addressed, indicates the degree to which the ACATS process has been both closed and flawed.

In December of 1991, DemoGraFX filed comments<sup>17</sup> with the FCC in response to a previous Notice in this same Advanced Television proceeding.

To summarize the issues raised in these DemoGraFX comments filed December 1991, which still remain an issue in the ACATS proposal which is the subject of the current Notice:

1. Interoperability (the ACATS proposal is anti-interoperable with computers)
2. Extensibility (the ACATS proposal precludes viable extension)

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<sup>17</sup> These comments should be on file at the commission. If you would like additional copies of these comments, please contact DemoGraFX.

3. Scalability (the ACATS proposal is not a scalable layered system)
4. Flaws in the testing process as applied to digital systems
5. Issues in the testing process applied to format-converted data
6. Suggestion that the formats be more open and flexible, and less restrictive
7. Recommendation of 72 Hz intended display rate
8. Problems with 59.94 and 60 Hz, due to display flicker on large bright screens
9. Desirability of provision for updating only a portion of the screen
10. Problems with 59.94 and 60 Hz when presenting 24-fps film (3-2 pulldown)
11. Problems with down-conversion to NTSC from HDTV interlaced formats
12. Problems with 59.94 Hz or 60 Hz when using computer displays
13. Problems with interlace when using computer displays
14. Problems with display of still images and text on interlaced displays
15. Suggestion that 24 fps movies can have higher resolution at a given bit rate, or a lower bit rate for similar resolution than higher frame rate formats.
16. Desirability of compatibility with a higher resolution production mastering format
17. Provision for international format conversions are needed
18. More focus needed on national information infrastructure
19. More focus needed on interactive uses
20. Recommendation that layered scalable systems (resolution, temporal, and bandwidth) be aggressively pursued.

Again, these issues remained unaddressed by the subsequent ACATS work. Note, in particular, that interactive uses have remained completely unaddressed by the ACATS proposal that this the subject of the current Notice. Such interactive uses are a key ingredient of a National Information Infrastructure in support of such applications as Health Care, Education, Work from Home, Library Access, etc. The lack of incorporation of proposals for interactive use, and the lack of plans for testing such proposals, indicates the degree to which the ACATS work has never seriously considered such uses. Such a fundamental flaw in the work of ACATS should be sufficient for the commission to reject its work until such interactive uses are enabled.

In late 1991, just prior to these comments, four of the five ACATS HDTV system proposers began to switch their recommended systems from analog to digital, (the exception being NHK, the Japanese Broadcaster). At this time, the Advanced Television Testing Center (ATTC) was still planning to test analog HDTV systems. After a many month delay, the digital and NHK systems were tested at the ATTC. However, this was done using analog inputs and outputs to the systems, in the same manner that the analog systems would have been tested. Further, no software simulation or testing was done, greatly reducing the thoroughness available to the

testing processing. As a consequence, the ACATS testing process at the ATTC was neither thorough nor appropriate for the digital television systems.

The most significant problem was that the ACATS process was not opened up to new submissions or participants as a consequence of the profound change in ATV implied by the switch to digital. As a result, the digital proposals have the same fundamental character as the analog proposals by the same proposers.

David H. Staelin also filed comments on 9 December 1991 in response to the same previous notice in this ATV proceeding (The current MM Docket No. 87-268)<sup>18</sup>. Professor Staelin's comments point out the need for interoperability, extensibility, and scalability. Dr. Staelin indicates the need for a clear ability to develop a roadmap toward advancement, through the use of technical mechanisms for extensibility and scalability. Such mechanisms have not been forthcoming. The packetization and header system within ACATS is not suitable for carrying data other than television video and audio. Additional services, which cannot tolerate the error rates of the ACATS proposed system, are precluded.

In October of 1992, the first ACATS Working Party 4 Interoperability Review was held. This review was held as a result of computer industry outcry that ACATS was not listening to its concerns, which were becoming much more relevant now that the systems were switching to digital. As a participant in this Interoperability Review, DemoGraFX attempted to express a wide range of concerns with the analog-television parameters which were being proposed in the digital HDTV systems, such as interlace, 60 Hz rates, and non-square pixel spacing (in some of the proposed systems). Dozens of other problems were also identified clearly to ACATS by DemoGraFX. The interoperability review panel was only able to ask two questions per panelist, so DemoGraFX submitted its long list of questions in writing. These questions are included in *Appendix C*. Note particularly the series of questions concerning resolution and temporal (frame rate) layering, as well as serious concerns regarding 60 Hz, 59.94 Hz, and interlace. The net consequence of this review was that none of the concerns expressed by DemoGraFX were addressed by ACATS, and few of the major problems identified by the DemoGraFX questions were corrected by the proposers. These same concerns were shared by many of the computer companies which participated in the interoperability review. The interoperability review thus appeared to serve no useful purpose toward improving the lack of interoperability inherent in the proposals before ACATS.

In late 1992, the systems were tested. At the October 1992 interoperability review, NHK dropped out of the running with their analog system, since the test results showed it to be significantly inferior to the all-digital systems. The digital systems, however, all had problems, and all tested about the same. In mid 1993, the "Grand Alliance" was formed on the basis that problems with each system needed to be fixed, and that none of the systems was demonstrably superior. Thus, a combined system might address these issues. However, the formation of the Grand Alliance marked the last point at which any significant change was to be made to the ACATS HDTV proposal. Subsequent to the formation of the Grand Alliance, the technology of the HDTV portion of ACATS did not change or improve to any significant degree up to the present.

In October of 1993, subsequent to the formation of the Grand Alliance, a second ACATS Working Party 4 Interoperability Review was held. ACATS chairman Richard Wiley was extremely hostile toward the idea of holding this review, and strongly opposed Apple and others who sought to

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<sup>18</sup> Additional copies of these comments are available from: Professor David H. Staelin, Room 26-341 Massachusetts Institute of Technology, Cambridge, MA 02139, Telephone: (617) 253-3711

shine light on the interoperability flaws in the Grand Alliance proposal<sup>19</sup>. However, with sufficient pressure from the computer industry, a second review was held. Again at this review, DemoGraFX raised numerous objections, this time in conjunction with Apple Computer, and pointed out numerous problems with the Grand Alliance proposal. As with the first interoperability review, these problems had to be formatted as questions. These questions are included in *Appendix D*. Note again the series of questions concerning resolution and temporal layering, as well as serious concerns regarding 60 Hz, 59.94 Hz, and interlace. Again, as with the first interoperability review, all of these objections were ignored. After the interoperability review, ACATS decided to "certify" the Grand Alliance proposal for fabrication and testing. At that point, DemoGraFX responded to many of the assertions being made concerning interlace that were announced by ACATS as part of its "certification". These DemoGraFX objections concerning interlace are shown in *Appendix E*.

At this time, in 1993, DemoGraFX and Apple both sought appointments to decision-making ACATS committees, and were denied these appointments by ACATS chairman Richard Wiley.

Between the formation of the Grand Alliance in mid 1993, and the final submission by ACATS to the FCC in December 1995, not one single objection raised in this interoperability review was addressed. Further, no changes of significance to interoperability were made to the Grand Alliance system subsequent to the initial formation of the Grand Alliance in mid 1993. Thus, the Grand Alliance proposed HDTV formats, which are now the subject of this Notice, have remained effectively unchanged since mid 1993<sup>20</sup>.

As a background, however, the Personal Computer Industry underwent a revolutionary advance in multimedia computing for the home and office between mid 1993 and the present. This revolution has progressed to the point where the majority of home computers now being sold are multimedia computers.

To have a frozen "Grand Alliance" standard, with frozen formats and system characteristics, through this period from 1993 through 1996 of rapid evolution in digital multimedia computers, is indicative of the gap that has existed between the ACATS process and the digital computer industry.

There was no discussion of formats within ACATS subsequent to the October 1993 interoperability review. ACATS became completely stagnant from that time until the present with respect to addressing the serious format flaws within the Grand Alliance HDTV format proposal. Since no formats were altered as a result of the criticisms at this October 1993 review, neither ACATS nor the Grand Alliance member companies were part of any "open" process. It is not an open process when serious criticisms are only heard, but never acted upon. An open process would have found mechanisms to address issues raised, and make appropriate adjustments. The posture of Grand Alliance presentations was to react to criticisms by explaining how the Grand Alliance proposed system handled these criticisms. That type of response, which

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<sup>19</sup> DemoGraFX, as a consultant to Apple on Digital Advanced Television, directly witnessed this hostility as an observer to a phone call from Richard Wiley to Mike Liebhold, then of Apple, discussing the need for this second review.

<sup>20</sup> The so-called "Standard Definition" 480-line formats were added to the Grand Alliance HDTV standard in the summer of 1995, and the HDTV name was changed to Advanced Television (ATV). However, the Grand Alliance HDTV formats have remained unchanged with the ATV format list, and the flaws in these formats have persisted without alteration since the formation of the Grand Alliance in mid 1993, until the present

has been consistent even to the present time, is equivalent to ignoring input, and is further verification that the ACATS process has been a closed process. There was never any public recognition by the Grand Alliance or ACATS that the criticisms were valid. The criticisms, as documented again here, have never been "handled" by the Grand Alliance system. The Grand Alliance system has been insular to criticism, thorough testing, or improvement. The ACATS process never established any process or mechanism for working to adjust the Grand Alliance proposal. Thus, the Grand Alliance proposal remains unmodified since it was originally proposed in mid-1993, and is unmodified as embodied in the ACATS proposal which is the subject of this Notice.

Work was pursued within the ATSC and within the Society of Motion Picture and Television Engineers (SMPTE) to "document" the Grand Alliance standard proposal. Within SMPTE, the Advanced Television Production (ATVP) working group was given the charter of specifying camera formats and associated scanning parameters for the Grand Alliance proposed system. DemoGraFX sought to widen this work to include computer-compatible frame rates (e.g. 24, 36, and 72), and the more pleasing 2.0 : 1 aspect ratio. DemoGraFX also sought to provide for extensibility in color and dynamic range. The ATVP specification was limited to specific parameters in the Grand Alliance proposed system, and was not extensible to cover the issues raised by DemoGraFX. DemoGraFX therefore drafted a complete alternative to the scanning parameters and submitted these to ATVP on 27 April 1994. These specifications, together with a cover description are included in *Appendix G*. Since this working group was comprised primarily of ACATS advocates, with a committee work statement limited to documenting ACATS formats, no action was taken by SMPTE, ACATS, or the ATSC on the DemoGraFX submission. However, by this submission, DemoGraFX submitted the relevant technical specifications in a timely manner, concurrent with the development of the Grand Alliance HDTV format technical specifications. This is yet a further indication of the closed nature of the ACATS process, and in this case the closed nature of SMPTE's work on documenting the ACATS formats.

There is a precedent for the relationship between open committee work and industry-led television proposals which stems from the original NTSC development. When our current national NTSC television system was being developed, a proposal from the Radio Manufacturer's Association (RMA) based upon a system developed by RCA, was used as the favored proposal being recommended to the FCC in 1939. The RMA Committee on Television had been active since 1929, and produced a final set of recommended standards to the FCC in 1939, coincident with a showing at the 1939 New York world's fair. The RMA standards were "in the hands of the FCC", and it was assumed that they would be adopted. The FCC granted licenses, and television sets were offered for sale. However, at a public hearing held January 15, 1940, there was industry outcry against this proposal from those outside of the RMA, as well as from some within the RMA. In particular, Allan B. DuMont Laboratories, Philo T. Farnsworth of Philco, Zenith, and others, objected to the proposed system as being technically inferior. Zenith and Philco objected to the RMA proposal even though they were both members of the RMA committee, as well as being advisors to RCA. There were alternate proposals put forth by those who were objecting, including a variable line and frame rate synchronization proposal from DuMont, and an 800 line system at 24 frames per second from Philco. These new proposals made a deep impression on the FCC. RCA then attempted to sell a larger number of sets at reduced prices to force the adoption of the RMA/RCA proposals. At this point, the NTSC committee was formed<sup>21</sup> by the FCC, being initiated in early 1940, and subsequently completing its work in July

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<sup>21</sup> For a complete history of the work of the NTSC committee, see "Television Standards and Practice, Selected Papers from the Proceedings of the National Television System Committee and Its Panels", Edited by Donald G. Fink, Mc Graw Hill Book Company, Inc., New York, 1943, Chapter 1, pp 1-17.

1941. Substantial and significant modifications were made to the original RCA/RMA proposal by the NTSC committee. Of major significance was a move to FM sound from the AM sound modulation being proposed by RMA. Of most significance, was a key modification involving the quality of the image. The RCA/RMA proposal used a carrier signal in the middle of the 6 MHz band, allowing 2.25 MHz of picture bandwidth. The NTSC committee modified this RCA proposal in a fundamental way by moving the carrier to the edge of the 6MHz band, and suppressing the lower side band. This yielded the 4.5 MHz of bandwidth of our present NTSC television signal, that remains its main performance characteristic to this day. The number of scanlines were also increased from 441 total lines to the current vertical resolution of 525 total lines, to augment the increased horizontal resolution. This resolution improvement was opened up due to the increase in bandwidth from 2.25 to 4.5 MHz. All of these changes were made after the RMA standards were thought to have been the final word. The commission made this possible by resisting pressure from RCA, which was then attempting to flood the market with sets in their proposed standard, and by forming the NTSC committee to deal with industry dissent and outcry for revision and improvement.

We can draw the analogy that we are now in the same situation, where we have a standard being proposed unilaterally by a partially-representative committee (ACATS), and a private industry group (the "Grand Alliance") to the FCC. We also have industry opposition from industries which both participated in that work, and from those who didn't. There is thus a precedent in the history of television development in the United States<sup>22</sup>, where the commission sent the industry-proposed standard back to committee for refinement, as happened with the commission's formation of the NTSC committee in 1940.

This doubling of performance, through interaction of the NTSC committee with the RMA/RCA proposal, is similar to the performance difference that the DemoGraFX system represents over the Grand Alliance HDTV formats within the ACATS proposal. DemoGraFX is achieving 144 MPixels/second, vs. the 60 MPixels/second of the Grand Alliance HDTV formats, representing an improvement factor of 2.4 times. This major increase in picture coding efficiency is an analogous improvement to the NTSC committee's improvement over the original RMA/RCA unilateral industry-led proposal. Thus, the commission would benefit from a similar improvement to the unilateral industry-lead ACATS proposal, based upon outside input similar to that which resulted in the formation of the NTSC committee, and the subsequent development of our current television system.

The commission in 1951 approved a CBS proposal for achieving color using a field-sequential method which was incompatible with the 1941 NTSC television system. Again, television sets were available in this system in stores, and licenses were granted by the commission. However, based upon complaints about this color system, the commission again reversed itself, this time forming the NTSC-II committee, which rapidly developed the backward-compatible color system which we still use today, finishing its work in 1953. Although this color system retro-fit was highly flawed, it did represent many advantages over the CBS system, especially considering how the lack of backward compatibility would obsolete a black-and-white NTSC television receiver population of about 10 million sets at that time.

These television history events indicate that the commission has found difficulties in its initial decisions based upon unilateral industry-lead proposals from partial segments of the television industry. These difficulties were handled by forming the NTSC and NTSC-II committees,

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<sup>22</sup> Although NTSC was setting the standard for only national U.S. television, this was really the first broadly deployed television system in the world.

resulting in reversal and abandonment of the commissions previous television decisions in support of the inferior RMA and sequential-color systems in 1940 and 1951.

Unlike the NTSC committees, the ACATS committee did not oversee any modifications or improvements to the unilaterally-proposed Grand Alliance HDTV proposal. ACATS put in place no mechanisms to seek such improvements, and there were no mechanisms even to allow improvements of such a fundamental nature. Subsequent to 1993, when the Grand Alliance formed, and unilaterally proposed its system, no committee action to scrutinize fully and improve the performance of the Grand Alliance system was undertaken by ACATS. ACATS held the interoperability review in October 1993, but no mechanisms were put in place to address the issues raised by the review, and no changes to the Grand Alliance system which affected interoperability were made subsequent to the review, up to and including the present time. ACATS treated the interoperability view as a chance to hear issues, but created no mechanism with which to address these issues raised, even though the issues were numerous and serious in nature. ACATS assigned the ATSC to "document" the Grand Alliance standard, but this did not allow any mechanism for scrutiny, modification, or improvement. Further, the ACATS process had not been opened to new entrants or competing proposals since before 1990. Unless the Grand Alliance members had unilaterally proposed a change to their system, which they didn't, no mechanism was in place for making such changes or improvements. The ACATS process therefore differs substantially in its operation from the process by which the NTSC committee operated. It bears remarkable resemblance, however, to the commission's television system selections of the proposal from RMA/RCA and from CBS, which were both subsequently reversed with the formation and recommendations of the NTSC-I and NTSC-II committees. It also bears resemblance in the industry outcry against the ACATS proposal, similar to the industry outcry which lead to the formation of the NTSC committees and the subsequent major revisions and improvements which yielded our current television standard. The work of the RMA committee bears particular resemblance to the ACATS and Grand Alliance work, in that it represented a small group of privileged future television system manufacturers, and was not broadly inclusive of the other interests. These other interest, however, ultimately prevailed in their insistence on rectifying flaws which they identified within the RMA proposal. The commission is now faced with the similar situation that those industries which have been essentially excluded from the ACATS process, and even those who have been partially included, are raising concerns over many fundamental technical issues within the ACATS proposal.

In mid 1995, discussions concerning formats occurred for the first time since mid 1993. However, these discussions were limited to proposals for new "Standard Definition Television" formats (SDTV). No discussion was allowed concerning the unilaterally proposed Grand Alliance HDTV formats.

The SDTV format discussions began in the ATSC in the late spring of 1995. DemoGraFX inquired of Bob Hopkins at the ATSC whether either DemoGraFX or Apple could participate in these discussions, since neither was a member of the ATSC. Bob Hopkins told DemoGraFX that DemoGraFX and/or Apple could attend meetings, and that all were welcome in sub-group meetings. However, neither DemoGraFX nor Apple could vote on any issues related to SDTV in main group meetings, because ATSC rules require that voting members not only join the ATSC, but be members for 6 months. Thus, since the SDTV deliberations were expected to last less than 6 months (they lasted about three), there was no way for either DemoGraFX or Apple to have a vote on SDTV formats within the ATSC.

DemoGraFX flew to Washington to two meetings of the ATSC which were represented as being crucial decision meetings for SDTV formats. One of these meetings was chaired by Stan Baron of NBC. At neither meeting was any discussion allowed of the SDTV formats, and DemoGraFX was not allowed to either participate or comment. Again, the work on the ATSC standard was a totally closed process.

In July of 1995, under protest concerning the closed nature of the ATSC, ACATS held an "open" meeting, in which DemoGraFX was allowed a few minutes to present, and discussion was allowed<sup>23</sup>. However, the SDTV formats were only allowed to be discussed in isolation. It was DemoGraFX' position that the proposed SDTV formats must form a family, or better yet a layered system, with the HDTV Grand Alliance proposed formats. However, such discussion was not allowed by ACATS, and the SDTV formats, including both interlace and non-square pixel spacing, and operating again at 59.94 and 60 Hz, were formulated. DemoGraFX submitted written comments to this meeting, as well as making a specific written proposal. The proposal was not considered, as has been typical of ACATS meetings. The written comments are attached as *Appendix H*.

Based upon this single "open" meeting, the 12 SDTV formats that are the subject of this notice were decided upon<sup>24</sup>. No testing was performed on the SDTV formats. No verification of their suitability for the United States, and no subsequent meetings or discussions were held between this one meeting and the final ACATS recommendation to the commission in December of 1995.

ACATS closed its activities with this December 1995 meeting, and with the corresponding recommendation to the commission. This recommendation and its proposed acceptance by the commission forms the core of the current Notice. Subsequent to this time, there have been no ACATS activities. ACATS proposal advocates, however, have been very actively attempting to promote and justify the ACATS proposal. These advocates will most likely attempt to broadly discredit all criticisms of the work of ACATS on procedural grounds. However, it has been the case in such ACATS defense and promotion that technical criticisms are dismissed or challenged with irrelevant facts rather than offering a credible technical response. In fact, ACATS proponents broadly admit the flaws of interlace, data error rate, receiver conversion requirements, aspect ratio, overscan, the 18 widely disparate formats, and most of the other problems within ACATS proposal. The justification is usually in the form that a "compromise" was made, yielding all of these flaws, to accommodate some special interest groups (in the guise of "broad industry consensus").

On February 3th of 1996, DemoGraFX gave the first public presentation of our Advanced Television system at the Winter SMPTE conference held in Seattle. This presentation was published in the proceedings of the conference, and is included as *Appendix I*. This document contains a complete description of the technical principles embodied in the DemoGraFX layered ATV system. With this paper, and with the CD-ROM's included with these comments, an independent evaluation can be made to verify our claims that this system out-performs the ACATS-proposed system by a wide margin, while also providing layering, computer compatibility, as well as satisfying the requirements of the movie making community.

The DemoGraFX system is also compatible with the principles being proposed by the Computer Industry Coalition on Advanced Television Service (CICATS), in that it utilizes a base layer which is consistent with the CICATS base layer guidelines.

DemoGraFX has been working for several years on developing the technology which is now embodied in our ATV system. During the fall of 1995, DemoGraFX began to see very promising results in layered compression. DemoGraFX then worked with Microsoft and Apple to design

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<sup>23</sup> This meeting was chaired by Bob Hopkins, then of the ATSC, now of Sony Hi Def Center.

<sup>24</sup> If the 1000/1001 ratio frame rates are considered, such as 59.94 Hz, there are actually 24 SDTV formats being proposed out of 36 total formats.

and implement a "stress-test" for this system. This stress test consisted of a series of ten shots, each having very high motion, to stress the compression capabilities to the maximum. The DemoGraFX ATV system tested extremely successfully against this stress test material, in tests run during the month of January 1996. DemoGraFX therefore decided to publicly announce these results at the SMPTE conference on 3 February 1996.

DemoGraFX has not been able to arrange for formal "non-expert-viewer" testing, as was performed at the Advanced Television Test Center (ATTC) to test the Grand Alliance system. DemoGraFX would like to perform such testing, but we feel the cooperation and oversight of the commission would be needed in order to ensure that such testing is deemed valid at the commission. We feel that such testing should be set up in competition with the Grand Alliance system, to formally verify our claim of superior compression technology.

The Grand Alliance proposed system was also tested by "expert-viewer" testing. DemoGraFX has been inviting industry experts to view our demonstration. These experts include members of the computer industry, the computer graphics production industry, and the film production community. The most highly trained visual experts are the members of the American Society of Cinematographers (ASC). DemoGraFX has worked with the ASC on shooting the stress tests, frame rate tests, and related compression test material. The ASC thus participated in the creation of the DemoGraFX ATV test material. The ASC has also provided members as expert viewers to scrutinize the DemoGraFX ATV test results. These expert viewers have deemed the DemoGraFX ATV system to be visually superior to the Grand Alliance proposed system. Several of these expert viewers have visited the commission and have given their personal account of what they have seen of the DemoGraFX ATV system demonstration<sup>25</sup>. DemoGraFX has thus attempted to provide independent verification to the commission of the validity of our ATV system.

Given that ACATS disbanded prior to DemoGraFX announcement, the only avenue available is to directly present these results to the commission. Beginning in February 1996, DemoGraFX has been seeking to invite the chairman, the commissioners, and associated commission staff to come see a demonstration of the DemoGraFX system. DemoGraFX is set up to demonstrate our results at our offices in Santa Monica, California. Members of the commission have recommended that we bring our demonstration to Washington DC. Unfortunately, our demonstration is not presently portable, in the same way that the Advanced Television Testing Center (ATTC) facility, used by ACATS, is not portable.

We therefore again extend an invitation to the commission to come and see our demonstration of layered and interoperable Advanced Television.

The very existence of the DemoGraFX system totally invalidates all of the formats being proposed by ACATS. Thus, DemoGraFX seeks for the commissioners to verify both its existence and technical validity. DemoGraFX is aware that ACATS proponents are denying both the existence and validity of our technology, even though none of these ACATS proponents have viewed our full results. DemoGraFX thus is deeply concerned about the continued closed nature of the ATV selection and proposal process within the United States. DemoGraFX recommends that formal work be chartered by the commission to evaluate and review DemoGraFX' technology, possibly recommending further refinements, in order to yield the best available ATV technology for our nation.

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<sup>25</sup> Steven Poster of the ASC, Don Mead of Hughes, Steven Gabriel and Alvy Ray Smith of Microsoft, and Jim Burger and Michael Ede of Apple Computer have all visited Saul Shapiro and others at the commission and have described their expert viewing of the DemoGraFX results.

This pattern of broad industry complaints to a more narrow unilateral industry proposal, has resulted previously in the opening up of committee revision and re-design work (by the NTSC and NTSC-II committees). The process of complaint and subsequent open committee revision has given us our present television technology, although these events happened a half a century ago. DemoGraFX seeks to draw this analogy with the present situation, although there are differences, especially in the level of technology and the pace of change. The commission might wish to consider television history and initiate a revision process to address the industry complaints about serious weaknesses within the unilateral ACATS proposal and alternative superior technologies such as our layered ATV system. This revision process should be broadly representative of the wider landscape of healthy United States industry.

The commission's role in AM Stereo, where competing systems were not arbitrated, but where a gamble was made using a market-force scenario ended without yielding any useful result. Consumers were never able to benefit from AM stereo, because the resulting market chaos inhibited the development of a critical-mass deployment of a viable system of transmission and reception. This undesirable result from letting the market forces have free reign might be duplicated in ATV, which could then deny our nation the benefit of improved television for either entertainment or for N.I.I. uses. The responsibility therefore falls to the commission to not only select a system, but to select an appropriate system through ensuring that N.I.I. compatibility and U.S. industry needs are met. This might be best handled by chartering a third national television standards committee, NTSC-III, to revise, repair, and improve the ACATS proposal.

Some members of the commission have indicated that they wish to proceed with ATV system adoption as rapidly as possible. This sentiment is echoed by the ACATS proponents, who urge that their system be hastily adopted without further scrutiny. This is an identical circumstance to that facing the commission in both 1940 and 1951, prior to the formation of the NTSC-I and NTSC-II committees. The RMA/RCA proponents not only urged rapid adoption, but attempted to force the issue through increased program transmission and by flooding the market with subsidized television sets in their proposed standard. The CBS system was also deployed via transmission and sets for sale to pressure the commission with adoption prior to the NTSC-II committee formation by the commission. As with the situation in 1940 and 1951, the ACATS proponents are asserting that a national technology lead might be lost if rapid adoption is not received for their proposal, despite dissent.

DemoGraFX would like the priorities in the selection of an ATV system to be first and foremost the choosing of the correct system for our nation's citizens, and as a distant second, the consideration of the interests of the proposers. There are very few interests in our nation which are urging rapid adoption outside of the ACATS proposers. DemoGraFX feels that the selection of the right system will yield a technical lead for our nation. We feel that the selection of the ACATS proposal will yield a broad and permanent setback to U.S. competitiveness, since it will be impossible to recall the flaws of ACATS's proposal such as interlace and 60 Hz, once deployed. These debilitating flaws will primarily impact our citizens in the critical areas of literacy, health care, and commercial competitiveness. ACATS proponents broadly admit to these flaws, but they suggest that a "migration strategy" can be used to correct these flaws at some later time. This assertion has been made since the 1993 interoperability review of the Grand Alliance proposal as an excuse for not attending to the proposal's shortcomings. However, in the intervening three years, no viable proposal has been put forward by ACATS or the Grand Alliance as to how even one of these serious flaws can be fixed after initial deployment. ACATS proponents have been unwilling to admit to the obvious fact that interlace and 60 Hz cannot be recalled, but rather that these features form permanent system characteristics which cannot be repaired without complete abandonment of the entire system of ATV equipment and receivers. Such abandonment would cause the waste of almost all broadcaster's and consumer's investments in the ACATS ATV system. There is no viable migration strategy for repairing the

flaws inherent in the ACATS proposal which is the subject of this Notice. The only sensible approach is to deploy the correct system, and to deploy it once. No interim deployment is viable, since interim deployment of the flawed ACATS proposal will result in drastic waste and unavoidable near-term abandonment. This will not only force economic waste, but will also postpone the time at which existing spectrum might be recovered.

DemoGraFX therefore is hopeful that the commission will seek the correct system for our nation above all other considerations.

## **2.1 Comments on the Testing Process (Paragraph 4 of the Notice)**

In paragraph 4 of the Notice, the 1988 ACATS plan for a testing center and testing procedures is described.

In 1987 and 1988, immediately following the inception of ACATS, both ACATS and the ATSC apparently attempted to recommend that the FCC adopt the Japanese HDTV standard as the U.S. Standard. However, due to numerous industry protests within the United States, that plan was abandoned. Nevertheless, the testing center began to be planned during this same time frame. As a consequence, the testing center is fundamentally constructed out of components which use the Japanese HDTV standard. It was obvious that no testing whatsoever of any differing standard would be possible unless some provision was made for handling alternate formats. The ACATS plan for handling alternate formats was to construct a format converter to operate with the tape machines and cameras which used the Japanese HDTV standard. However, format converters, especially related to cameras, always degrade the image to some degree. An attempt was made to acquire non-interlaced cameras, but these prototype cameras were very noisy, and therefore did not provide suitable test pictures.

In the end, all of the Grand Alliance testing was done using cameras which operated in the Japanese HDTV format, as well as film material converted to this format. Given the history of the process, and the early attempt by ACATS to adopt the Japanese HDTV standard for the United States, the ACATS committee should have been more sensitive to the biases introduced into the testing process by basing the Advanced Television Testing Center (ATTC) on equipment which operated in the Japanese HDTV standard. That bias is still reflected in the current ACATS proposal which is the subject of this notice in the form of the 1920 x 1080 format which operates at 60 Hz and 59.94 Hz interlaced.

Another fundamental flaw in the testing process relates to the 1988 plan for the testing center. The fundamental assertion is that prototype hardware would be required in order to test the candidate HDTV systems. The Advanced Television Testing Center (ATTC), was established to test these hardware implementations. The ACATS premise was that an analog HDTV system must be tested with real-time hardware.

Although this premise is probably valid for an analog HDTV system, it is not valid for a digital system. When the proponents switched their proposals from analog to digital in 1992, the testing process should have been drastically altered. As it was, ACATS made very little modification to either the testing process or the testing center (ATTC) as a result of the radical shift from analog HDTV proposals to digital system proposals.

With digital systems, it is more typical to exhaustively test via software simulation. The reason for this is that hardware implementations are often inflexible, and testing options are usually limited, as was the case with the ACATS digital proposals. However, software simulations allow a broad range of testing, which have proven superior in testing and optimizing system designs. Software simulation and testing is the norm for large digital systems, and not the exception.

The modulation system, and associated error correction performance, is appropriate for real-time hardware implementation and field testing. It is inherently an analog system, and should be tested as one with real hardware.

However, the packetization, video coding, audio coding, and display performance are much more suited to software simulation testing than to hardware implementation.

In practice, the 1992/1993 ATTC testing did not distinguish sufficiently between the prototype digital systems, although flaws were discovered, these flaws were usually hardware implementation bugs (errors), rather than system design flaws.

This lack of distinction between the digital proponents was only partly due to the relative similarity of the systems. The testing process was fundamentally run by ACATS committees composed primarily of HDTV system proponents. It was the over-arching goal of these committees to make sure that every system came out looking good. There was little, if any, attempt to thoroughly test any of the systems or formats. It was pointed out many times to ACATS by DemoGraFX, beginning in 1989, that the digital television proposals should be "stress tested", to understand their capabilities and limitations. Unfortunately, only a few statistically insignificant stress tests were allowed into the testing process. The greater number of tests, which formed the statistical weight in the test results, were very low motion scenes resulting in very low stress.

In 1992 and 1993, there was a great deal of controversy surrounding the limited inclusion of those tests that showed problems with the interlaced formats. It was the ACATS committee's minimization of the number of such tests that allowed the interlace formats to test acceptably in both rounds of testing. This testing bias angered many in the computer industry who were observing the testing process.

In late 1994, the Grand Alliance system went into the testing center for testing. The 1994/95 ATTC testing round for the Grand Alliance system did nothing other than verify that the system worked to provide an acceptable picture and audio, and that the bugs were fixed. There was no comparative testing. Only the one system was tested. The formats could be compared, but again they tested statistically similar, mainly due to the biases in the material used for testing. There were two out of twenty-five tests which showed the severe flaws of the 1920 x 1080 interlaced formats, and showed the benefits of removing interlace. Because these tests were less than 10% of the number of tests, the very significant differences in test results for these two tests were "buried in the noise" of the other twenty-three results.

Thus, objective testing of either the pre-Grand-Alliance digital HDTV system proponents, or the Grand Alliance system itself, was never performed. Instead, heavily biased testing was performed with the goal of making all of the systems look good. In fact, the committee was so-composed by ACATS that any test which would make an interlaced system look bad in the test results (beyond the insignificant number of such tests allowed) was eliminated from the testing process.

DemoGraFX therefore asserts that the testing process was inappropriate for the digital HDTV systems that were tested, and that only the modulation, transmission, and error-correction tests were valid.

DemoGraFX and Apple attempted to point out the need for interoperability testing to ACATS working party 6. However, ACATS rejected the requests for these additional tests. A letter was sent to ACATS detailing the inability of the ACATS testing process to perform the desired interoperability tests, and the problems and concerns that would therefore remain unaddressed.

A description of these issues and problems, as sent by DemoGraFX and Apple to ACATS WP6 in April of 1993, is attached as *Appendix F*.

It should also be pointed out that the so-called "Standard Definition" 480-line television formats, which were added by ACATS in the summer of 1995, were not tested by the ATTC or elsewhere. These formats were added to the ACATS list of formats with no ACATS or ATTC testing whatsoever.

Thorough tests of the quality loss due to interlace would certainly eliminate the 480-line interlaced formats from any fair competition with the 480-line non-interlaced formats<sup>26</sup>.

In DemoGraFX' independent testing of our own system, a series of ten high-motion shots were used. These stress-tested our system far beyond any of the tests used by the ATTC on the Grand Alliance system testing, which was tested with a couple dozen low-stress shots. DemoGraFX therefore believes that we have tested our ATV system more thoroughly than the tests performed on the Grand Alliance system.

DemoGraFX's testing was limited to the compression part of our ATV system. DemoGraFX did not implement or test a packet or modulation layer. DemoGraFX' system was designed to fit into the bit budget available (18.5mbits/second) for HDTV picture data within the total available bit rate of the ACATS system (19.3 mbits/second). Thus, the DemoGraFX system replaces everything above the packet layer, including all ACATS-proposed formats, with a system which is layered in resolution and frame rate.

DemoGraFX believes that our ATV system will out-perform the ACATS-proposed system at every single resolution and frame rate being proposed by ACATS. Further, DemoGraFX system offers layered compression, eliminating the need for 18 formats, as proposed by ACATS.

DemoGraFX would like to suggest to the commission that a new round of objective and thorough testing be performed. This new round of testing can be used to directly compare the DemoGraFX ATV system with the ACATS proposed ATV system. DemoGraFX is confident that our ATV system will not only outperform the ACATS system, but will provide numerous key features, such as layering, which the ACATS proposal cannot provide. These extra features yield an ATV system which is far more compatible with computers and movie making requirements than the ACATS system. Further, these features greatly reduce the cost to consumers of ATV receivers, while also improving the quality of the picture at every level of receiver (at both ATV and SDTV levels).

## **2.2 Comments on the ATSC DTV Standard (Paragraph 7 of the Notice)**

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<sup>26</sup> Non-interlaced formats are also called "progressive scan" formats. However, many capture media, such as film and CCD-based cameras (the most common type of modern television camera), do not scan. The image is integrated over the whole area of the frame. However, the picture information is conveyed in a scanning order, from left to right and top to bottom, leading to the notion of progressive scanning. To add further confusion, "Proscan" is also used as a shorthand for "progressive scan". However, Thomson uses a "Proscan" brand of consumer televisions, some of which are interlaced! For these reasons of clarity, DemoGraFX prefers to use the term "non-interlaced" over "progressive scan", although progressive scan is more prevalent in the Notice. The terms are equivalent for the purposes of this Notice and our comments on the Notice.